Earth battery Light / Charger

An **Earth battery** is a pair of electrodes made of two dissimilar metals, such as iron and copper, which are buried in the soil or immersed in the sea. Earth batteries act as water activated batteries. If the plates are sufficiently far apart, they can tap telluric currents. Earth batteries are sometimes referred to as telluric power sources and telluric generators.

History

One of the earliest examples of an earth battery was built by Alexander Bain in 1841 in order to drive a *prime mover*—a device that transforms the flow or changes in pressure of a fluid into mechanical energy.[1][2] Bain buried plates of zinc and copper in the ground about one meter apart and used the resulting voltage, of about one volt, to operate a clock. Carl Friedrich Gauss, who had researched Earth's magnetic field, and Carl August von Steinheil, who built one of the first electric clocks and developed the idea of an "Earth return" (or "ground return"), had previously investigated such devices.

Daniel Drawbaugh received U.S. Patent 211,322 for an Earth battery for electric clocks (with several improvements in the art of Earth batteries). Another early patent was obtained by Emil Jahr U.S. Patent 690,151 *Method of utilizing electrical Earth currents*). In 1875, James C. Bryan received U.S. Patent 160,152 for his *Earth Battery*. In 1885, George Dieckmann, received US patent U.S. Patent 329,724 for his *Electric Earth battery*. In 1898, Nathan Stubblefield[3] received U.S. Patent 600,457 for his electrolytic coil battery, which was a combination of an earth battery and a solenoid. (For more information see US patents 155209, 182802, 495582, 728381, 3278335, 3288648, 4153757 and 4457988.) The Earth battery, in general, generated power for early telegraph transmissions and formed part of a tuned circuit that amplified the signalling voltage over long distances.

Operation and use

The simplest earth batteries consist of conductive plates from different metals of the electropotential series, buried in the ground so that the soil acts as the electrolyte in a voltaic cell. As such, the device acts as a primary cell. When operated only as electrolytic devices, the devices were not continuously reliable, owing to drought condition. These devices were used by early experimenters as energy sources for telegraphy. However, in the process of installing long telegraph wires, engineers discovered that there were electrical potential differences between most pairs of telegraph stations, resulting from natural electrical currents (called telluric currents[4]) flowing through the ground. Some early experimenters did recognize that these currents were, in fact, partly responsible for extending the earth batteries' high outputs and long lifetimes. Later, experimenters would utilize these currents alone and, in these systems, the plates became polarized.

It had been long known that continuous electric currents flowed through the solid and liquid portions of the Earth,[5] and the collection of current from an electrically conductive medium in the absence of electrochemical changes (and in the absence of a thermoelectric junction) was established by Lord Kelvin.[6][7] Lord Kelvin's "sea battery" *was not* a chemical battery.[7] Lord Kelvin observed that such variables as placement of the electrodes in the magnetic field and the direction of the medium's flow affected the current output of his device. Such variables do not affect battery operation. When metal plates are immersed in a liquid medium, energy can be obtained and generated,[8] including (but not limited to) methods known via magneto-hydrodynamic generators. In the various experiments by Lord

Kelvin, metal plates were symmetrically perpendicular to the direction of the medium's flow and were carefully placed with respect to a magnetic field, which differentially deflected electrons from the flowing stream. The electrodes can be asymmetrically oriented with respect to the source of energy, though.

To obtain the natural electricity, experimenters would thrust two metal plates into the ground at a certain distance from each other in the direction of a magnetic meridian, or astronomical meridian. The stronger currents flow from south to north. This phenomenon possesses a considerable uniformity of current strength and voltage. As the Earth currents flow from south to north, electrodes are positioned, beginning in the south and ending in the north, to increase the voltage at as large a distance as possible.[9] In many early implementations, the cost was prohibitive because of an over-reliance on extreme spacing between electrodes.

It has been found that all the common metals behave relatively similarly. The two spaced electrodes, having a load in an external circuit connected between them, are disposed in an electrical medium, and energy is imparted to the medium in such manner that "*free electrons*" in the medium are excited. The free electrons then flow into one electrode to a greater degree than in the other electrode, thereby causing electric current to flow in the external circuit through the load. The current flows from that plate whose position in the electropotential series is near the negative end (such as palladium). The current produced is highest when the two metals are most widely separated from each other in the electropotential series, and when the material nearer the positive end is to the north, while that at the negative end is towards the south. The plates, one copper and another iron or carbon, are connected above ground by means of a wire with as little resistance as possible. In such an arrangement, the electrodes are not appreciably chemically corroded, even when they are in earth saturated with water, and are connected together by a wire for a long time.[*citation needed*]

It had been found that to strengthen the current, it was most advantageous to drive the northerly electropositive electrode deeper into the medium than the southerly electrode. The greatest currents and voltages were obtained when the difference in depth was such that a line joining the two electrodes was in the direction of the magnetic dip, or magnetic inclination. When the previous methods were combined, the current was tapped and utilized in any well-known manner.[*citation needed*]

In some cases, a pair of plates with differing electrical properties, and with suitable protective coatings, were buried below the ground. A protective or other coating covered each entire plate. A copper plate could be coated with powdered coke, a processed carbonaceous material. To a zinc plate, a layer of felt could be applied. To use the natural electricity, earth batteries fed electromagnets, the load, that were part of a motor mechanism.

What is happening here is similar to a Galvanic Cell. Although in a drought the "batteries" are of little use. The plate made of the less noble (base) will experience galvanic corrosion. Protecting the base from corrosion will stop the battery from working. Not all of the Earth battery patents operate on galvanic corrosion method of utilizing electrical earth currents. I tested it and achieved 0.6 VDC with a copper and iron pipe spaced 4.5 ft north-south in moist soil. In the patents galvanic corrosion should only account for 0.3 VDC. There are references being used to plans claiming the device draws ether in addition to conventional electricity. "An Introduction to the Mysteries of Ground Radio" favors calling it geomantic energy. Whether these are correct or not is debatable. Earth Batteries principle of action is not totally known, and further research is required.

They can act as receivers of natural noise sources and telluric currents

Earth Batteries and Joule Thieves

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Earth Battery 101

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The simplest earth batteries consist of conductive plates from different locations in the electropotential series, buried in the ground so that the soil acts as the electrolyte in a voltaic cell. As such, the device acts as a non-rechargeable battery. When operated only as electrolytic devices, the devices were not continuously reliable, owing to drought condition. These devices were used by early experimenters as energy sources for telegraphy. However, in the process of installing long telegraph wires, engineers discovered that there were electrical potential differences between most pairs of telegraph stations, resulting from natural electrical currents (called telluric currents) flowing through the ground. Some early experimenters did recognize that these currents were, in fact, partly responsible for extending the earth batteries' high outputs and long lifetimes. Later, experimenters would utilize these currents alone and, in these systems, the plates became polarized.

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The **Baghdad Battery**, sometimes referred to as the **Parthian Battery**, is the common name for a number of artifacts created in Mesopotamia, during the dynasties of Parthian or Sassanid period (the early centuries AD), and probably discovered in 1936 in the village of Khuyut Rabbou'a, near Baghdad, Iraq. These artifacts came to wider attention in 1938 when Wilhelm König, the German director of the National Museum of Iraq, found the objects in the museum's collections. In 1940, König published a paper speculating that they may have been galvanic cells, perhaps used for electroplating gold onto silver objects. Though far from settled, this interpretation continues to be considered as at least a hypothetical possibility.[4][5]If correct, the artifacts would predate Alessandro Volta's 1800 invention of the electrochemical cell by more than a millennium. The artifacts consist of terracotta pots approximately 130 mm (5 in) tall (with a one-and-a-half-inch mouth) containing a copper cylinder made of a rolled-up copper sheet, which houses a single iron or (galvanized nail) rod. At the top, the iron rod is isolated from the copper by bitumen plugs or stoppers, and both rod and cylinder fit snugly inside the opening of the jar, which bulges outward toward the middle. The copper cylinder is not watertight, so if the jar was filled with a liquid, this would surround the iron rod as well. The artifact had been exposed to the weather and had suffered corrosion, although mild given the presence of an electrochemical couple. This has led some to believe that wine, lemon juice, grape juice, or vinegar was used as an acidic electrolyte solution to generate an electric current from the difference between the electrochemical potentials of the copper and iron electrodes. König thought the objects might date to the Parthian period (between 250 BC and AD 224). However, according to St John Simpson of the Near Eastern department of the British Museum, their original excavation and context were not well-recorded (see stratigraphy), so evidence for this date range is very weak. Furthermore, the style of the pottery is Sassanid (224-640).

"**Joule thief**" is a nickname for a minimalist self-oscillating voltage booster that is small, low-cost, and easy-to-build; typically used for driving light loads. It can use nearly all of the energy in a single-cell electric battery, even far below the voltage where other circuits consider the battery fully discharged (or "dead"). Hence the name suggests the notion that the circuit is *stealing* energy or "Joules" from the source. The term is a pun on the expression "jewel thief", one who steals jewelry or gemstones.

The circuit uses the self-oscillating properties of the blocking oscillator, to form an unregulated voltage boost converter. As with all power conversion technology, no energy is actually created by the circuit. Instead, the output voltage is increased at the expense of higher current draw on the input. As a result, the amount of power entering the circuit is the same as the amount leaving, minus the losses in the conversion process.

The circuit works by rapidly switching the transistor. Initially, current enters the transistor base terminal (through the resistor and secondary winding), causing it to begin conducting collector current through the primary winding. This induces a voltage in the secondary winding (positive, because of the winding polarity, see dot convention) which turns the transistor on harder. This self-stoking/positive-feedback process almost instantly turns the transistor on as hard as possible (putting it in the saturation region), making the collector-emitter path look like essentially a closed switch (since V_{CE} will be only about 0.1 volts, assuming that the base current is high enough). With the primary winding effectively across the battery, the current increases at a rate proportional to the supply voltage divided by the inductance. Switch-off of the transistor takes place by different mechanisms dependent upon supply voltage.

The predominant mode of operation relies on the non-linearity of the inductor (this does not apply to air core coils). As the current ramps up it reaches a point, dependent upon the material and geometry of the core, where the ferrite saturates (the core may be made of material other than ferrite). The resulting magnetic field stops increasing and the current in the secondary winding is lost, depriving the transistor of base drive and the transistor starts to turn off. The magnetic field starts to collapse, driving current in the coil into the light emitting diode (raising the voltage until conduction occurs) and the reducing magnetic field induces a reverse current in the secondary, turning the transistor hard off.

At lower supply voltages a different mode of operation takes over: The gain of a transistor is not linear with V_{CE}. At low supply voltages (typically 0.75v and below) the transistor requires a larger base current to maintain saturation as the collector current increases. Hence, when it reaches a critical collector current, the base drive available becomes insufficient and the transistor starts to pinch off and the previously described positive feedback action occurs turning it hard off.

To summarize, once the current in the coils stops increasing for any reason, the transistor goes into the cutoff region (and opens the collector-emitter “switch”). The magnetic field collapses, inducing however much voltage is necessary to make the load conduct, or for the secondary-winding current to find some other path.

When the field is back to zero, the whole sequence repeats; with the battery ramping-up the primary-winding current until the transistor switches on.

If the load on the circuit is very small the rate of rise and ultimate voltage at the collector is limited only by stray capacitances, and may rise to more than 100 times the supply voltage. For this reason, it is imperative that a load is always connected so that the transistor is not damaged. Note that, because V_{CE} is mirrored back to the secondary, failure of the transistor due to a small load will occur through the reverse V_{BE} limit for the transistor being exceeded (this occurs at a much lower value than V_{CE}max).

The transistor dissipates very little energy, even at high oscillating frequencies, because it spends most of its time in the fully on or fully off state, thus minimizing the switching losses.

The switching frequency in the example circuit opposite is about 50 kHz. The light-emitting diode will blink at this rate, but the persistence of the human eye means that this will not be noticed.

When a more constant output voltage is desired, a voltage regulator can be added to the output.

Joule Thieves can be used with Fuji Circuits (flash circuit board from disposable fuji cameras) to really ramp up the power!
Capacitors can be used to store up and release the telluric energy collected by an earth battery. Using capacitors and a Fuji Circuit it is possible to get an earth battery to provide short periods of high power load. Joule Thieves and Fuji Circuits are also used to draw current from low output batteries.

A **joule thief** is a minimalist self-oscillating voltage booster that is small, low-cost, and easy to build, typically used for driving small loads. This circuit is also known by other names such as *blocking oscillator*, *joule ringer*, or *vampire torch*. It can use nearly all of the energy in a single-cell electric battery, even far below the voltage where other circuits consider the battery fully discharged (or "dead"); hence the name, which suggests the notion that the circuit is *stealing* energy or "joules" from the source – the term is a pun on "jewel thief". The circuit is a variant of the blocking oscillator that forms an unregulated voltage boost converter. The output voltage is increased at the expense of higher current draw on the input, but the integrated (average) current of the output is lowered and brightness of a luminescence decreased.

Description of operation

The circuit works by rapidly switching the transistor. Initially, current begins to flow through the resistor, secondary winding, and base-emitter junction (see diagram) which causes the transistor to begin conducting collector current through the primary winding. Since the two windings are connected in opposing directions, this induces a voltage in the secondary winding which is positive (due to the winding polarity, see dot convention) which turns the transistor on with higher bias. This self-stroking/positive-feedback process almost instantly turns the transistor on as hard as possible (putting it in the saturation region), making the collector-emitter path look like essentially a closed switch (since V_{CE} will be only about 0.1 volts, assuming that the base current is high enough). With the primary winding effectively across the battery, the current increases at a rate proportional to the supply voltage divided by the inductance. Transistor switch-off takes place by different mechanisms dependent upon supply voltage.

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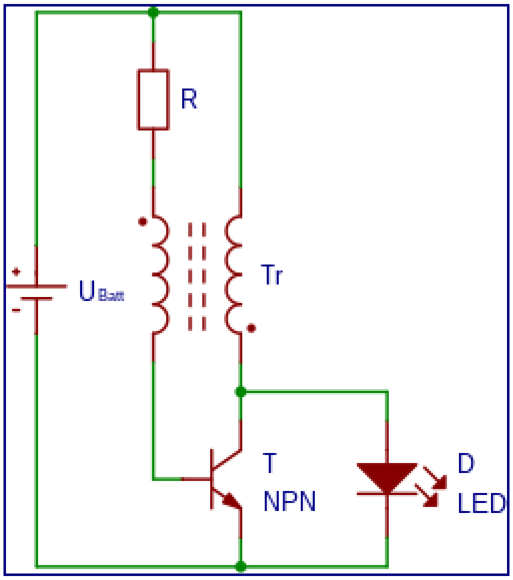
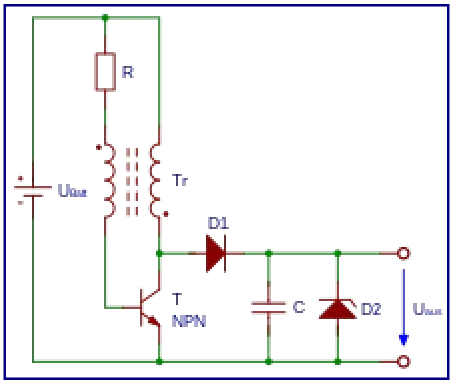


Example of a joule thief circuit driving an LED. The coil consists of a standard ferrite toroid core with two windings of 20 turns each using 0.15 mm (0.006 inch) diameter wire (38 swg) (34-35 AWG). The circuit can utilize an input voltage down to about 0.35 V and can run for weeks using a 1.5 V LR6/AA. The battery voltage is usually 1.5 V. The resistor is ~1 kΩ, 1/4 W. The transistor could be a 2N3904, BC547B, 2SC2500, BC337, 2N2222, 2N4401 or other NPN. V_{ceo}= 30 V, P= 0.625 W.

Simple voltage limiter

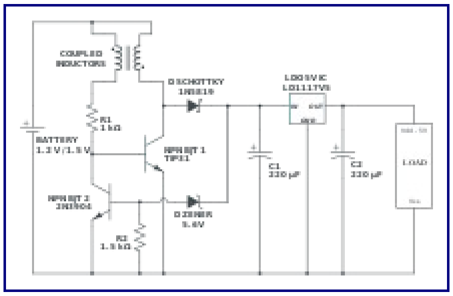


Joule thief with regulated output voltage

A simple modification of the previous schematic replaces the LED with three components to create a simple zener diode based voltage regulator. Diode D1 acts as a half-wave rectifier to allow capacitor C to charge up only when a higher voltage is available from the joule thief on the left side of diode D1. The Zener diode D2 limits the output voltage. As there is no regulation, any excess of energy not consumed by the load, will be dissipated as heat in the zener diode with consequent low efficiency of conversion.

A better solution is shown in the next schematic example.

Closed-loop regulated joule thief



A closed-loop regulated joule thief

When a more constant output voltage is desired, the joule thief can be given a closed-loop control. In the example circuit, the Schottky diode D1 blocks the charge built up on capacitor C1 from flowing back to the switching transistor Q1 when it is turned on. A 5.6 Volt Zener diode D2 and transistor Q2 forms the feedback control: when the voltage across the capacitor C1 is higher than the threshold voltage formed by Zener voltage of D2 plus the base-emitter turn-on voltage of transistor Q2, transistor Q2 is turned on diverting the base current of the switching transistor Q1, impeding the oscillation and prevents the voltage across capacitor C1 from rising even further. When the voltage across C1 drops below the threshold voltage Q2 turns off, allowing the oscillation to happen again. This very simple circuit has the drawback of temperature-dependent output voltage due to BJT2 (Vbe), and a relatively high ripple, but can be filtered with a simple LC pi network with low losses. In the example circuit, is included a low dropout regulator which contributes to regulating further the output voltage and lowers the ripple, but has the penalty of low conversion efficiency

The joule thief is not a new concept. Basically, it adds an LED to the output of a self-oscillating voltage booster, which was patented many decades ago.

- US Patent 1949383,[1] filed in 1930, "*Electronic device*", describes a vacuum tube based oscillator circuit to convert a low voltage into a high voltage.
- US Patent 2211852,[2] filed in 1937, "*Blocking oscillator apparatus*", describes a vacuum tube based blocking oscillator.
- US Patent 2745012,[3] filed in 1951, "*Transistor blocking oscillators*", describes three versions of a transistor based blocking oscillator.
- US Patent 2780767,[4] filed in 1955, "*Circuit arrangement for converting a low voltage into a high direct voltage*".
- US Patent 2881380,[5] filed in 1956, "*Voltage converter*".
- US Patent 4734658,[6] filed in 1987, "*Low voltage driven oscillator circuit*", describes a very low voltage driven oscillator circuit, capable of operating from as little as 0.1 volts (lower voltage than a joule thief will operate). This is achieved by using a JFET, which does not require the forward biasing of a PN junction for its operation, because it is used in the depletion mode. In other words, the drain–source already conducts, even when *no* bias voltage is applied. This patent was intended for use with thermoelectric power sources.

Design#1: Joule thief 1 watt LED Driver

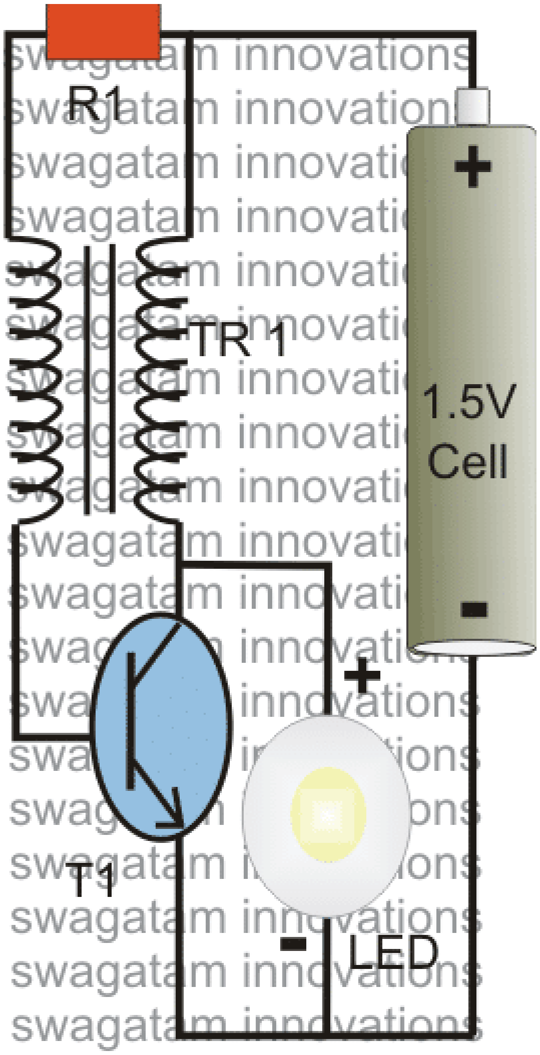
The present article discusses 3 such circuits, however here we replace the traditional 5mm LED with a 1 watt LED.

The concept discussed here remains exactly identical to the usual joule thief configuration, we just replace the normally used 5mm LED with a 1 watt LED.

Of course this would mean the battery getting drained pretty much earlier than a 5mm LED, but it's still economical than using a two 1.5 cells and not including a joule thief circuit.

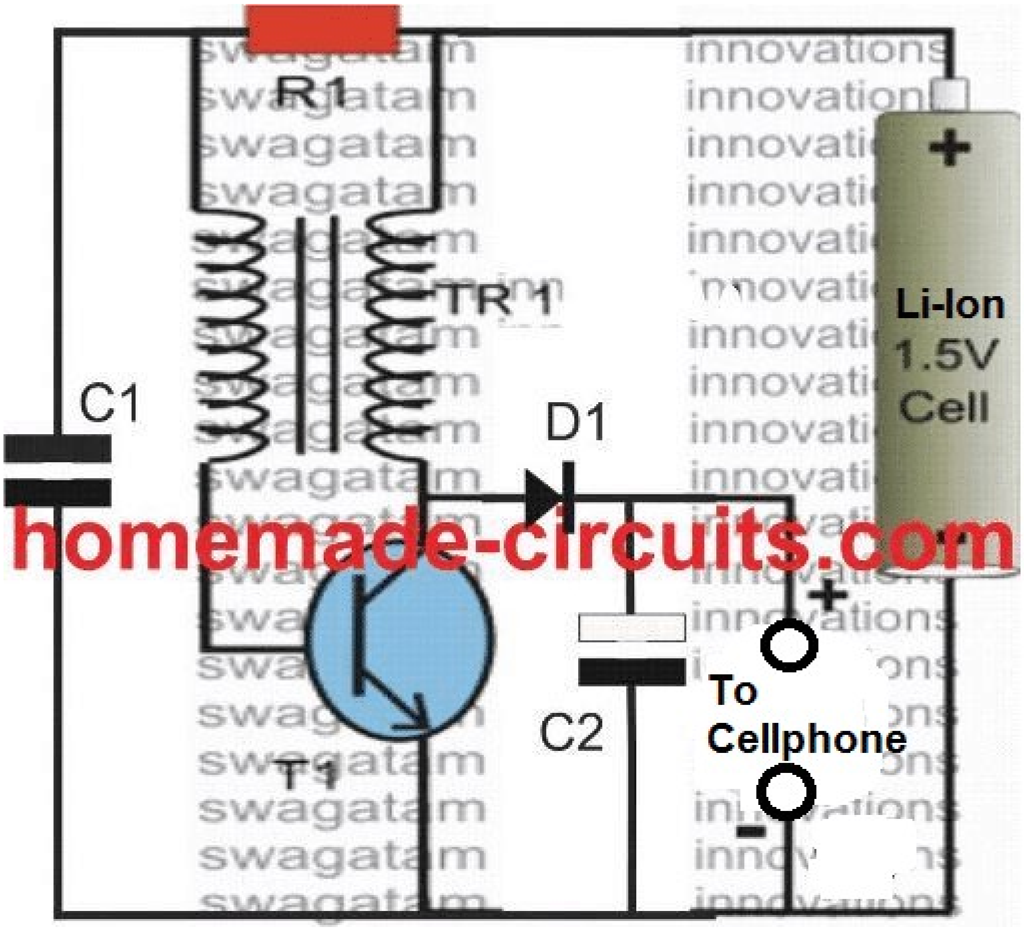
Let's try to understand the proposed circuity with the following points:

If you see the circuit diagram the only seemingly difficult part is the coil, rest of the parts are just too easy to configure. However if you have a suitable ferrite core and some spare thin copper wires, you would make the coil within minutes.



swagatam innovations

The above design may be improved further by attaching a rectifying network using a diode and a capacitor, as shown below:



Parts List

- R1 = 1K, 1/4 watt
- C1 = 0.0047uF/50V
- C2 = 1000uF/25V
- T1 = 2N2222
- D1 = 1N4007 better if BA159 or FR107 is used
- Coil = 20 turns each side using 1 mm enameled copper wire over a ferrite ring which accommodates the winding comfortably

The coil may be wound over a T13 torroidal ferrite core using a 0.2mm or 0.3mm super enameled copper wire. About twenty turns on each side will be quite enough. In fact any ferrite core will, a ferrite rod or bar will also serve the purpose well.

After this is done, its all about fixing the parts in the shown manner.

If everything is done correctly, connecting a 1.5 V penlight cell would instantly illuminate the attached 1 watt LED very brightly.

What is an Earth Battery, and How Does It Work?

Among the latest clean energy innovations, the Earth battery is perhaps the most accessible.

It generates electricity from the soil and can be built by anyone using simple electrical components and tools. There's no need for expensive turbines or complex circuitry that are often required of renewable energy systems. You can build your homemade earth batteries using just a handful of copper spikes, galvanized nails, and copper wire.

If that description makes you doubt the earth battery's potential, don't. Earth batteries can produce up to 5 volts – enough to power everyday electronics such as radios, lamps, and mobile phones.

They're one of the most powerful clean energy systems for off-grid communities and homes. In this article, we explore what an earth battery is and how you can build one yourself.

What is an Earth battery?

An earth battery is a type of water-activated battery that produces an electrical current using electrochemical reactions in the soil. Made from just four simple components – copper cathodes, zinc anodes, copper wires, and wet earth – an earth battery produces enough energy to power lamps and radios in off-grid locations.

Like all batteries, it relies on the exchange of electrons from zinc and copper electrodes to produce an electrical current. The electrodes are immersed in an ion-rich electrolyte solution where electrons from zinc transfer to copper, generating the electrical charge we use to power our electrical devices.

But unlike other batteries, earth batteries use wet soil or bacteria-rich compost as the electrolyte solution instead of acids. Organic matter releases electrons as it decomposes, which can be captured by the electrodes. Electrons are also discharged when bacteria eat organic matter like they do in compost piles.

This scientific finding may sound like a recent discovery, but it came about as early as the 1840s by an inventor named Alexander Bain. Bain was looking for a cheap, ubiquitous energy source to power telegraph lines when he hypothesized about the earth's potential electric energy.

He put zinc and copper plates in damp soil to test his theory and discovered that the earth produced an electric charge that could be harnessed. Although it wasn't enough to power telegraph lines, Bain's discovery was the spark that gave birth to the concept of the earth battery.

Now almost two hundred years later, earth batteries have grown in popularity thanks to increased public demand for off-grid and clean energy technologies. Most people build their own homemade earth batteries just like Bain did, although a few renewable energy startups have tried producing prototypes for commercial distribution.

Earth batteries can produce a charge of about 1 to 5 volts, depending on the construction and type of soil used. Recent research shows that earth batteries could work as an alternative or complementary source of energy to wind and solar power.

How much does an Earth battery cost?

Earth batteries can cost anywhere from $10 to more than $500 depending on the amount of energy you want to derive from them.

You only need to consider the material and equipment costs of earth batteries when installing them. Unlike other clean energy systems, earth batteries are very easy to set up on your own without needing to hire any specialized laborers.

A small earth battery, for example, can be made from an ice cube tray, galvanized nails, and copper wire that should cost you no more than $20. An earth battery of this size is about the size of your hand and can produce enough energy to light a lamp or run a clock.

If you live in an agricultural area where chicken wire and animal manure are easy to find, you might even be able to build an earth battery for just $10.

This earth battery requires a paint bucket, a chicken wire cathode, a graphic cloth anode, and mud mixed with manure, saltwater, and some sand. It can provide the same amount of charge as the $20 ice cube tray earth battery.

For people who want to build an earth battery large enough to power the lights and small electrical appliances in their home, a budget of about $500 should suffice. This will cover the cost of multiple copper spikes, galvanized nails, high-value capacitors, and rolls of copper wire.

You may also want to consider getting a high-quality voltmeter and a pair of wire strippers to test and assemble your earth battery. A voltmeter costs about $15 while a decent pair of wire strippers should cost no more than $10.

All earth battery components can be easily bought at hardware stores. It’s only the soil that you’ll need to scoop up from your backyard or purchase from a plant nursery.

How well do Earth batteries work?

Of the various earth battery (ground battery) designs out there, the traditional soil-based earth battery and its newer compost counterpart are the most effective.

They work in the same way, producing electricity from electron exchanges, but have different strengths and weaknesses.

The soil-based earth battery can produce up to 5 volts per single battery, which is more than enough to power a small electronic device with an LCD screen such as a calculator, clock, or pedometer.

It relies on moisture in the soil to transport ions between the copper and zinc electrodes. When the soil dries up, usually about 2-3 days after it has been moistened, the battery stops producing a charge. Wetting the soil again helps rekindle the charge.

But once the soil itself has been depleted of all ions and electrolyte properties, the earth battery will go dead. This is when you’ll need to replace the soil with a fresh batch.

On the other hand, compost-based earth batteries, often referred to by researchers as microbial fuel cells (MFC), produce electrical currents when bacteria break down organic matter in the compost and other types of waste.

Researchers discovered that these earth batteries produce about 0.5 to 1 volt per single battery, which is enough to power a microcomputer such as a Gameboy, the handheld gaming device from the 1990s.

The bacteria help release electrons as long as they have food to break down. Replenishing their food supply can keep compost-based earth batteries running for months or years as the bacteria eat and continue multiplying.

The only problem with microbial fuel cells is that the electrons given off by bacterial activity don’t transfer well to the electrodes. As a result, the electrical current produced is relatively low.

Can I build my own homemade earth battery?

Anyone can build an earth battery on their own.

There are numerous youtube videos and guides online that you can easily follow and use to construct your own earth battery design.

The biggest considerations you would need to make before building an earth battery are the amount of energy you want from it and the amount of soil you can access. To power a few lamps in a small- or medium-sized home, you would need a large surface area of soil to assemble your earth battery system on.

A small earth battery for recharging phones, on the other hand, would just require a handful of soil or compost packed with bacteria.

It should take you no more than 30 minutes to build a small earth battery. Large earth batteries may take a few hours to build as you’ll need to stake out the locations of the electrodes, plant them, and connect them to copper wires and then to your home.

How to install an Earth battery

To install an earth battery, you have to first decide where you want to place it.

Small earth batteries are portable and work both indoors and outdoors. They can be installed a few feet away from the appliance that will rely on the battery’s power.

Large earth batteries require an expansive area of soil and can therefore only be installed outdoors. The most important factors to determine before installing a large earth battery are the amount of space required and the availability of a water source close to the location you’ve identified.

This is because ground batteries need constantly moist soil to perform well. Runoff from an irrigation system or a septic tank drain field can help provide the water that’s needed.

Once you’ve identified a location for your earth battery, you’ll need to construct it. For large earth battery systems, you might find it useful to install them as line batteries with pairs of zinc and copper spike electrodes planted 5 to 6 feet from each other. This will create a series of ‘batteries’ that draw ions from the earth. It’s best to experiment with what works best on your property.

After you connect the electrodes to a copper wire, you can hook the battery up to your home’s lighting system circuit.

The same installation process applies to small earth batteries. The only difference is that instead of planting a series of electrodes into the ground, small single-cell earth batteries will usually only require a cathode (such as a galvanized nail or chicken wire), an anode (such as a graphite cloth), and a container full of soil or compost.

An earth battery installation at your home can help you reduce your electricity bill, and maybe even your carbon footprint. It’s a free energy source that’s ideal for off-grid living, wherever you may be.

Patents

- A. Bain, "U.S. Patent 5,957 *Copying surfaces by electricity*".
- A. Bain, "U.S. Patent 6,328 *Improvements in electric telegraphs*".
- W. P. Piggot, "U.S. Patent 050,314 *Telegraph cable*".
- W. D. Snow, "U.S. Patent 155,209 *Earth-batteries for generating electricity*".
- J. Cerpaux, "U.S. Patent 182,802 *Electric piles*".
- Daniel Drawbaugh, "U.S. Patent 211,322 *Earth battery for electric clocks*".
- M. Emme, "U.S. Patent 495,582 *Ground generator of electricity*".
- M. Emme, "U.S. Patent 728,381 *Storage Battery*".
- Jahr, Emil, "U.S. Patent 690,151 *Method of utilizing electrical earth currents*".
- Bryan, James C., "U.S. Patent 160,151 *Improvements in lightning rods*".
- Bryan, James C., "U.S. Patent 160,152 *Earth Battery*". February 23, 1875.
- Bryan, James C., "U.S. Patent 160,154 *Improvements in lightning rods*".
- James M. Dices, "U.S. Patent 2,806,895 *Immersion type battery*".
- Dieckmann, George F., "U.S. Patent 329,724 *Electric Earth Battery*". November 3, 1885.
- Stubblefield, Nathan, "U.S. Patent 600,457 *Electric battery*". May 8, 1898.
- William T. Clark, "U.S. Patent 4,153,757 *Method and apparatus for generating electricity*".
- Ryeczek, "U.S. Patent 4,457,988 *Earth battery*". July 3, 1984.

US690151A

United States

Method of utilizing electrical earth-currents.

Description

Nl-TED STATES PATENT EM IL JAHR, OF BERLIN, GERMANY.
METHOD OF u'nuzmc ELECTRICALEARTH-CURRENTS;
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Application an. m, 24,1900. seen Io. steam: (K was) To all whom it may concern:
specification;
It is known that continuous electric currents ilowthrou'gh the solid and B35151 r- 'tions of the earths' crust. Lamont strom und der Zusammenhang deaselbn mit dem Erdmagneti'smus, Leipsic, 1862) showed the existence of such currents by thrusting two metal plates at a certain distance from eaclso'ther into the ground in the direction ofthe magnetic or astronomical meridian and connecting them above the ground by means of a wire including a galvanometer. The stronger currents 0t this kind have beenshown to flow from south to north. Later observations (Weinstein, Electrotechn'icche Zeitschrift, 1898, p. 794) show that this socalled earth-current possesses a considerable uniformity of current strength and pressure. From the fact that this earth-current flows from south to north itmay be concluded that its pressure will increase if starting from a given point in the south the distance between this and the northern point is increased,
provided the connecting-lead be of little resistance. Notwithstanding that these facts have been known the earth-current has neverbeen utilized; because in order to vobtain a s'uflicient current the distance between the north and south points must be so great that the cost of an installation is prohibitive. I

have discovered that the south to northdirection of the earth-current is maintained only when the plates: are of the same metal. When zinc isused for the southern plate and iron or carbon for the northernone, the current flows through the lead connecting them fromnorth to south. All the common metals behave relatively similarly-rthat is, the current flows always from that plate'whose position in the separated in the electricalpoten'tial series .and the northerly and more electropositive ordinary electrical potential serie'sis near the negative end, (palladium) I have also discovered that the current produced is of highpoint, while that which is nearer the negsti end (palladium) of the series is thrust into earth or water at the. southerly point, In such air-arrangement the netalsare not up preciably chemically corroded, even when they are in earth saturated with water, and
are connected together by lead fora'long time;
My invention relates, therefore, to a method two electrodes, of which the one has'a posi'-' tion north of the other and is of a material nearer to the positive end (zinc)'of the elecfor utilizing the earth-current, consisting in thrusting into the earth or'water on the earth trical potential series than is the material 0L the other electrode and connecting the two above ground by a lead. It is advantageous that the northerly more electropositive electrode should he thrust more deeply ,into the earth or water than the southerly electrode, for then the current is stronger. The best result as to strength of current and pressure is obtained when this diflerence in depth is such that a line joining the two electrodes is in the direction of the magnetic dip. The best, efiect, therefore, is obtained when these conditions are combined-'-namely, when the two electrodes are approximately in the magnetic meridian and are of materials widely electrode is buried at a greater" depth than that at which the southerly electrode is buried and that a line joining them has the inclina- 7 tion of the magnetic dip. The curreutcan be tapped from the lead joining the electrodes and utilized in any well-known manner.

US329724A

United States

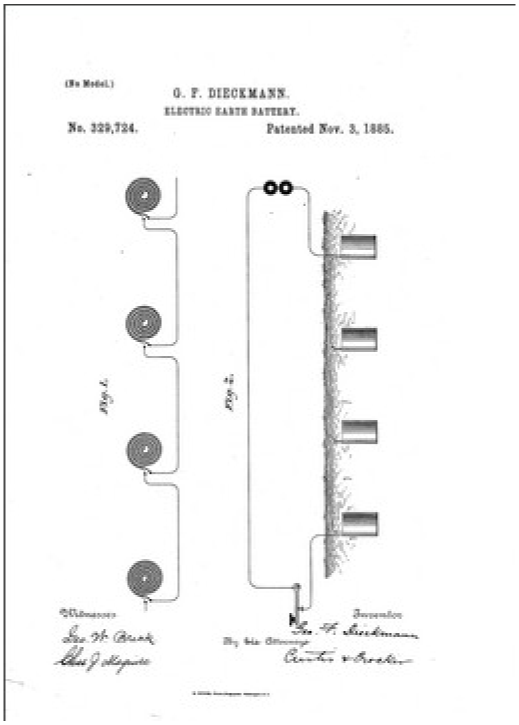
ELECTRIC EARTH-BATTERY

Earth batteries, consisting of electrodes buried in the earth, as heretofore constructed, have not been capable of giving an electromotive force greater than that obtainable from a single couplewhich is too small for practical purposes-because, if a number of "couples or elements were used and connected in series all the couples stood in the same electrolyte and short-circuited one another. By my invention I am enabled to bury a series of couples in the same body of earth and connect them together in series, so as to obtain from such a battery an indefinitely high electro-motive forcesufficient for charging storagebatteries, operating electric bells, telegraphic and other purposes, &c.
To this end my invention consists in arranging the electrodes in such a way that the resistance between the electrodes of each couple is small, while the resistance between the couples is relatively large, and connecting the negative electrode of each with the positive electrode of the next by a low-resistance conductor, so that the short-circuiting effect of the couples upon each other may be indefinitely reduced, and the effect is practically the same as if the couple were immersed in separated electrolytes. To arrange the relative resistances so as produce this effect I place the two electrodes of each couple comparatively near together, and the separate couples relatively far apart, so that the resistance between one electrode of one couple and the same electrode of the next couple is very much greater than the resistance between the two electrodes of the same couples, and consequently the shortcircuiting effect is reduced comparativelyto nothing.
My invention is illustrated in the accom panying drawings, Figure 1 representing my arrangement of electrodes in plan, and Fig. 2 showing them in elevation buried in the earth.
In my battery any electrodes may be used, 50 and they may be of any desired size and shape;

I but in order to make the internal resistance of the battery as low as possible and obtain a cheap construction, I prefer to form each elementor couple of zinc and copper plates or sheets separated the proper distance by a sheet of felt, asbestus, or other suitable nonconducting material and rolled up in a spiral form, as clearly represented in the drawings, by which means I obtain a compact element having a large surface with a small distance between the plates, and consequently a very low resistance. The zinc plate being the one most acted upon should be made the thicker, as I have indicated. Having constructed any desired number of these elements according to the electro-motive required, I bury them in the earth at a proper depth in any desired positions, but relatively far apart, so that the distance between them is great compared with the distancebetween the two electrodes of any one couple. The negative plate of each couple is then connected with the positive plate of the next through the series, as representedand the terminals of the battery thus formed are connected with the circuit to be supplied, a telegraph-circuit, as represented, for example. The wires connecting the couples should preferably be insulated where they come near together below ground, to prevent short-circuiting there. I have shown them entirely buried in the earth; but of course they may be laid above ground. The distance apart that the couples should be placed depends upon the resistance of the telegraphic or other working circuit. If its resistance be very high, -then the couples should be much farther apart, in order that the difference of potential between one electrode of one couple and the same electrode of the next couple may be high compared with the difference of potential between the two electrodes of the same couple. Similarly, the end couples of the battery should be so far apart with reference to the resistance of the working-circuit that the resistance between them through the earth is great compared with the resistance of the working-circuit, so that the working-circuit will not be short-circuited; or, to express it more accurately, the earth-resistance between the end couples should be so high that the fall of potential through it is great compared with-the fall through the workingcircuit; This effect is obtained by making the distance between the end couples correspondingly greater than that between adjacent couplesby arranging the couples in a straight line, for example.

By thus properly proportioning the resistance between the couples to the circuit-resistanceand internal resistance of the couples,the shortcirouiting effect may be reduced more or less to an insignificant amount, and any desired electro-motive force obtained from the battery.

I claim as my invention- 1. An earth-battery consisting of a number of couples or elements buried in the earth and connected in series, the two electrodes of each couple being placed near together, while the couples or elements are placed comparatively 'fa'r apart, whereby the short-circuiting effect



US495582A

United States

Ground generator of electricity

Myinvention relates to chemical generators of electricity, a prepared body of earth being used as the support and exciting medium for the electrodes or elements. In a generator constructed in accordance with my invention, any desired number of elements may be assembled in the same piece of ground and coupled in series or multiple series to produce the electro-motive force desired. I find that if a series of galvanic couples belinserted in a body of ground so that a straight line will pass transversely through the several couples and the space between the several couples be made large comparatively to the distance between the two elements composing the c0uples, the couples may be joined for series in the same manner as if they were contained in independent Vessels. In order, however, to attain the best results it is necessary to prepare the body of soil immediately adjacent to the two elements composinga couple in a manner which will be hereinafter fully described.

The several features of novelty of the invention will be hereinafter more fully described in this specification and definitely indicated in the claims appended to this specification.

In the accompanyingdrawings Figure l illustrates an earth generator in which the several couples are arranged in series. Figs. 2 and 3 show a cross section of ground containing one couple. Fig. Llshows wedge shaped elements with a suitable solution rich in oxygen, chlorine, bromine, iodine or fluorine, or with a solution of a salt of an alkali. As elements I prefer to use iron as a positive electrode and hard pressed coke carbon for the negative electrode. The positive electrode is preferably a U-shaped bar of iron round in cross section. The two limbs of the U straddle a rod of carbon. The iron should be soft wrought iron. Cast iron also can be used, but I find that cast iron gives a little less electro-motive-force, probably by reason of the percentage of carbon and other impurities contained therein. Magnesium also yields excellent results producing with carbon a voltage of 2.25. Zinc, aluminium or any metal with which the ground and its contained salts or exciting medium will develop electrolytic y action may be used with varying results.

In carrying my invention into practice I level a piece of ground of sufficient area to contain the generator. For instance, for three hundred positive elements each twenty inches long and two inches in diameter bent as indicated in Fig. 3, and three hundred negative elements fifteen inches long and three inches in diameter, the length of the piece of ground should be about one hundred feet and its width about three feet. I dig forty-three holes, at a distance of thirty inches apart from center to center, in a line as indicated in Fig. l. Each hole is ten inches wide and thirty inches broad and of a depth sufficient to contain the elements. The loose soil dug from the ground is mixed with a proper salt or acid to render the generator active. For instance,if the ground is a vegetable mold commercial concentrated nitric acid should be added in sufficient quantity to saturate the.

is then introduced, the composite elements being immersed in it. The several groups of elements thus arranged may be connected in series by conductors as shown in Fig. l, though the generator will act without any external conductors except the terminal wires. A generator constructed as above described will yield 53.85 volts and fifty-six ampres, developing a total of 3,015.60 watts, or about four horse-power. By increasing the number of cells the capacity of the generator may be correspondingly increased to any desired horse-power. The couples may 'be joined in simple series or in multiple series. The prepared body of soil should be periodically moistened preferably with the acid with which it was treated when first prepared for action, and in a plant constructed for continuous action I prefer to provide a reservoir as indicated at A in Fig. 6 and run a pipe of a material not attacked by the acid throughout the plant providing nozzles over the several couples so that they may be moistened when desired. With provisions of this nature the soil may be keptin a substantially uniform condition and the generator rendered continuously serviceable. Any accumulation of oxides or other products of the reaction between the prepared soil and the elements may be removed and a clean metal surface exposed for chemical action by raising the positive electrode and then forcing it back into place again. The carbon may be cleansed by simply turning it Without lifting it from its place.

I find that the period of activity of the generator during which no addition of salt or acid is required increases with the length of service. For example,during the first day of use the exciting' medium should be added after ten hours of Work, after which it will yield twenty-six hours of service, and then after another addition of excitant it will yield service for two days, and so on.

In Fig. lis represented a generator the several electrodes of which are composed of rods grouped in multiple and arranged as indicated in Fig. 2 where B represents the solid ground and C .the mass of prepared soil.

inferior results are obtained by such an arrangement) as indicated at G.

The dotted lines Fig. 5 indicate the directions of electro-motive-force in the internal circuits, 1, 2, 3, 4, 5, 6 being in one direction and 7, S and 9 in an opposite direction. There lines in Fig. 5, the solid ground acting as a h conducting medium. Thus the internal resistance of the generator is lowered and the output of the generator consequently increased. The fact that such internal circuits actually exist may be demonstrated by the interposition of a voltmeter in the ground between successive pairs of elements; the whole body of earth in the neighborhood of the generator seems to be permeated with stream lines of electric energy. p This fact probably assists in some Way to prevent polarization of the negative electrodes as the battery acts with great constancy.

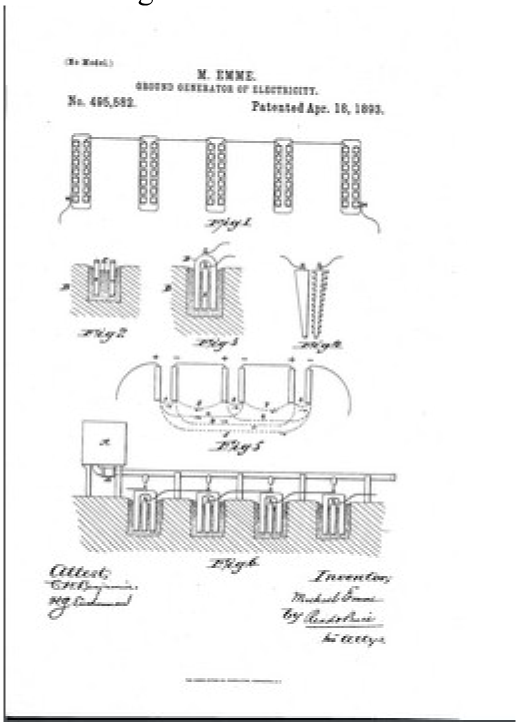
Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is-

1. A generator of electricity comprising a series of galvanic couples each couple bein-g embedded in an electrolytic medium composed of earth mixed to a pasty consistency with an exciting solution the spaces between the several couples being occupied by unprepared earth.

2. A ground generator of electricity comprising a series of galvanic couples embedded in an electrolytic medium composed of earth mixed to a pasty consistency with a suitable excitant and filled in holes

formed at intervals in the earth.

3. A ground generator of electricity comprising a series of galvanic couples embedded in ythe earth and connected in series relation, the distance between the several couples being large compared to the distance between the elements of any couple, and a reservoir for periodically supplying a moistening medium and maintaining the action of the generator.



US155209A

United States

Improvement in earth-batteries for generating electricity

Be it known that I, WILLIAM D. SNOW, of Brook1yn,'in the State of New York, have invented a certain Improvement in Earth-Batteries for Electro-Magnetic Alarms, 850.; and I do hereby declare the following to be a full and correct description of the same, reference being had to the accompanying drawing, which represents a series of electromagnetic signaling or alarm apparatus placed in a house and operated by a current derived from an earth-battery, as hereinafter more fully set forth.

The object of my invention is to avoid the employment of artificial electric batteries for the purposes of house-signaling, fire and burglar alarms, and for the operation of other circuits.

In the common systems employed for these purposes a local or house battery is employed, requiring to be. kept in working order by the occupants of the building in which it is placed, who are usually entirely ignorant of its structure and uses; or else the street line of wires is carried into the house, and thus subjected to all the contingencies to which the house itself is liable.

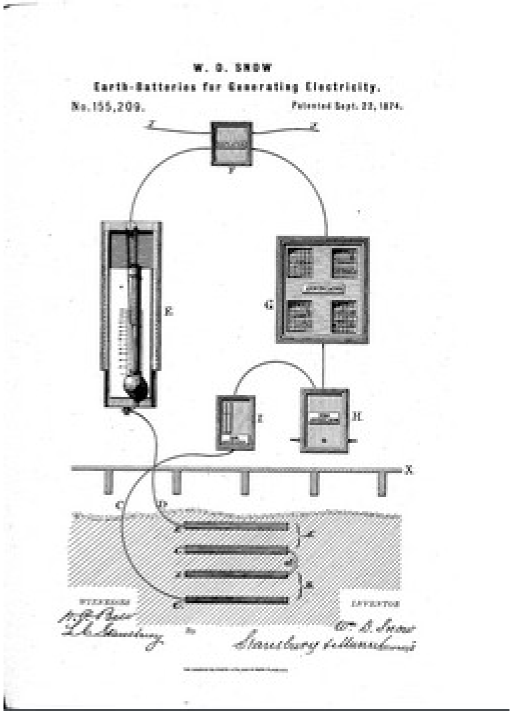
I obviate the trouble, annoyance, and danger to public safety incident to the systems referred to, by employing the current from an earthbattery without the intervention of any cups or vessels containing acids or other agents for the decomposition of zinc or other metals, commonly called a battery. This I efl'ect by making use of an earth-battery formed by burying the electrodes in the earth under the house at the depth of permanent moisture, so that the action of the dampness of the earth upon the plates will develop a sufficient permanent current for the required purposes. From these buried plates I run a telegraphic circuit in the house to connect with thermostats, signaling apparatus, fire and other alarms, annunciators, gas-lighters, or repeaters, according to the nature of the use to which the electric current is to be applied.

Some attempts have been made to use earth-batteries for Various purposes. 'Such earth-batteries were made by simply burying a single set of elements in the earth, and proved of little or no practical value, on account of the very feeble intensity of the current generated. I have discovered, however, that if a series of elements be used in the earth, coupled together so as to form an earthbattery of any required size, this objection is obviated, and a constant current of considerable intensity is obtained, capable of operating steadily quite an amount of apparatus.

In the drawing, A and B mark two series of electrodes, which may be of zinc and carbon, as marked 0 and Z, buried in the earth under the'house in which the circuit is to be used, the wire 01 being a connection between the dissimilar elements of the two series; 0 D, the wires for conducting the current, which may be made to complete the circuit by passing through E, an automatic thermostat; F, a repeater, connected with the street-wires J J Gr, an annunciator; H, afire-annihilator; or I, a signal-writing-bar apparatus, either one or more of these, each operated by the current in any of the usual modes.

What I claim is- 1. The improved earth-battery, consisting of a series of elements buried in the. earth and connected together to form a battery, substantially as and for the purposes set forth.

2. The combination of two or more electric currents or circuits, when one of these is a current derived from an earth-battery, substantially as described, and is employed to operate the other or others.



Metals and soils

Potential differences of metals

(Soil galvanic series)

Metal	Potential
...	V Cu/$CuSO_4$ electrode
Magnesium (pure)	-1.75
Magnesium (alloy)	-1.60
Zinc	-1.10
Aluminum (alloy)	-1.05
Aluminum (pure)	-0.8 22
Steel (clean)	-0.50 to -0.80
Steel (rusted)	-0.20 to -0.50
Cast iron	-0.50
Lead	-0.50
Steel (concrete)	-0.20
Copper	-0.20
Brass	-0.20
Bronze	-0.20
Steel (mill scale)	-0.20
Cast iron (high silicon)	-0.20
Carbon	+0.30
Graphite	+0.30
Coke	+0.30

Notes:

- Non-uniform conditions at node surface results in different voltages

Ref.: Engineering Tutorials: Potential of Metals in Soils

Theory

The Earth Battery could be connected to a Joule Theif for a permanent light or charging source.